PC-Based Supercomputing for Uncertainty and Sensitivity Analysis of Models

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Evaluating uncertainty and sensitivity of multimedia environmental models that integrate assessments of air, soil, sediments, groundwater, and surface water is a difficult task. It can be an enormous undertaking even for simple, single-medium models (i.e. groundwater only) described by only a handful of variables and a unique set of site-specific data. The challenge then of examining ever more complex multimedia models, with 100s to 1000s of variables, is a formidable one. Today, quantitative assessment of integrated multimedia models that simulate hundreds of sites, spanning multiple geographical and ecological regions, is becoming a standard risk assessment question for national policy development.

A characteristic of uncertainty and sensitivity analyses for very high order models (indicating large numbers of variables) is their need for significant levels of computational capacity to perform large numbers of individual model simulations. While this aspect is emerging as a critical area for environmental model evaluation, resources for Windows-based, PC-based modeling have been limited by an associated lack of supercomputing capacity. Supercomputing achieved through use of personal computer (PC) clusters has expanded rapidly in recent years. Less common though are clusters that support Windows-based approaches. To facilitate model evaluation tasks for EPA's modeling systems, NERL-Athens has developed a Windows-based 270^{+} GHz PC-based Supercomputer for Model Uncertainty and Sensitivity Evaluation (SuperMUSE). Design and construction of SuperMUSE is described here.

Extendable to many of EPA's computer models, conceptual layout of an accompanying platform-independent, Java-based parallel processing software tool set is also discussed. Together, the hardware and software tool set concept represents a key component of future modeling frameworks that the Agency is moving toward, and will ultimately strengthen our ability to validate regulatory-based modeling efforts. Advantages of the technology developed include: 1) the approach is scalable to individual user (or program office) needs (i.e. clustering from 2 to 2000 PCs), 2) it can be applied to any Windows-based modeling system (and also works for Linux systems), 3) it's targeted to deliver a specific capability (i.e. uncertainty and sensitivity analyses), 4) it's a local solution, delivering to researchers and clients autonomy from large supercomputing centers formally providing these services, and 5) it's cheap and can be constructed and operated by relative novices with limited knowledge of computer science. Relating this to how we meet client needs, examples of national-scale and site-scale multimedia application are presented for key environmental exposure and risk assessment problems.

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